

VOLUME 1

ADVANCES IN FOOD SCIENCE AND TECHNOLOGY

EDITED BY

Visakh P. M., Sabu Thomas,
Laura B. Iturriaga, and Pablo Daniel Ribotta

 **Scrivener
Publishing**

WILEY

Advances in Food Science and Technology

Edited by

Visakh P. M., Sabu Thomas, Laura B.
Iturriaga, and Pablo Daniel Ribotta



Copyright © 2013 by Scrivener Publishing LLC. All rights reserved.

Co-published by John Wiley & Sons, Inc. Hoboken, New Jersey, and Scrivener Publishing LLC, Salem, Massachusetts.

Published simultaneously in Canada.

No part of this publication may be reproduced, stored in a retrieval system, or transmitted in any form or by any means, electronic, mechanical, photocopying, recording, scanning, or otherwise, except as permitted under Section 107 or 108 of the 1976 United States Copyright Act, without either the prior written permission of the Publisher, or authorization through payment of the appropriate per-copy fee to the Copyright Clearance Center, Inc., 222 Rosewood Drive, Danvers, MA 01923, (978) 750-8400, fax (978) 750-4470, or on the web at www.copyright.com. Requests to the Publisher for permission should be addressed to the Permissions Department, John Wiley & Sons, Inc., 111 River Street, Hoboken, NJ 07030, (201) 748-6011, fax (201) 748-6008, or online at <http://www.wiley.com/go/permission>.

Limit of Liability/Disclaimer of Warranty: While the publisher and author have used their best efforts in preparing this book, they make no representations or warranties with respect to the accuracy or completeness of the contents of this book and specifically disclaim any implied warranties of merchantability or fitness for a particular purpose. No warranty may be created or extended by sales representatives or written sales materials. The advice and strategies contained herein may not be suitable for your situation. You should consult with a professional where appropriate. Neither the publisher nor author shall be liable for any loss of profit or any other commercial damages, including but not limited to special, incidental, consequential, or other damages.

For general information on our other products and services or for technical support, please contact our Customer Care Department within the United States at (800) 762-2974, outside the United States at (317) 572-3993 or fax (317) 572-4002.

Wiley also publishes its books in a variety of electronic formats. Some content that appears in print may not be available in electronic formats. For more information about Wiley products, visit our web site at www.wiley.com.

For more information about Scrivener products please visit www.scrivenerpublishing.com.

Cover design by Russell Richardson

Library of Congress Cataloging-in-Publication Data:

ISBN 978-1-118-12102-3

Printed in the United States of America

10 9 8 7 6 5 4 3 2 1

Advances in Food Science and Technology

Scrivener Publishing
100 Cummings Center, Suite 541J
Beverly, MA 01915-6106

Publishers at Scrivener

Martin Scrivener (martin@scrivenerpublishing.com)
Phillip Carmical (pcarmical@scrivenerpublishing.com)

Preface

“Advances in Food Science and Technology” summarizes many of the recent technical research accomplishments in the area of food science and technology, such as food security as a global problem, nanotechnology in food application, frozen food and technology food: production, properties & quality, trace element speciation in food, bionanocomposites for food packing application etc. It is written in a systematic and comprehensive manner and recent advances in the developments in food science area and food technologies are discussed here in detail. Therefore, the content of the current book is unique. It covers an up-to-date record on the major findings and observations in the field of food science and food technology and it is intended to serve as a “one stop” reference resource for important research accomplishments in this area. The various chapters in this book are contributed by prominent researchers from industry, academia and government/private research laboratories across the globe. This book will be a very valuable reference source for university and college faculties, professionals, post-doctoral research fellows, senior graduate students, food science technologists and researchers from R&D laboratories working in the area of food science.

The first chapter on food chemistry and technology gives an overview of the area of food science and technology such as food security a global problem, nanotechnology in food application, frozen food and technology food: production, properties & quality, trace element speciation in food, bionanocomposites for food packing application. This chapter is very essential for the beginners in these fields since it provides a basic yet thorough understanding of the food science field.

The following chapter provides an overview on food security as a global problem. The first part of this chapter reviews food security: definitions and basic concepts, main causes of food insecurity including social issues, economic issues, environmental issues and

later in the chapter, the authors explain the various aspects of the food insecurity dimension such as current situation at global level, financial and economic crisis and their implications on food security. Lastly, they look at food prices volatility, food sector numbers: trends in global food production and trade.

A survey on nanotechnology in food application is tackled in the third chapter. The authors concentrate on the importance of nanotechnology in food science, applications and also address some of the challenges. This chapter also brings out new innovative methods for food formulations and novel applications such as food packaging, enhanced barrier, active packaging, and intelligent packaging.

The fourth chapter on frozen food and technology comprises several subtopics. The first topic looks at pre-freezing treatments of different food products such as fruits, vegetables, fish, and meat products. In the another topic, the authors explain about the freezing methods and equipment such as freezing by contact with cold air, freezing by contact with cold liquid, freezing by contact with cold surfaces, cryogenic freezing and combination of freezing methods. The last section of this chapter, the authors explain the effect of freezing and frozen storage on food properties such as physical changes, chemical changes, microbiological aspects

The following chapter on chemical and functional properties of food components provides the basic understanding of food components, nutritional value and sensory, post harvest storage and processing. This chapter gives an overview of functional and chemical properties of food components with some subtopics such as functional foods: historical perspective and definitions, legislation on functional food claims, classification of functional foods and functional properties of food components.

Another chapter examines the new aspects on food production, food properties and food quality. In this chapter the authors mainly focus on the food production factors such as, soil, climate, population, income and technology, plant source foods and animal source foods.

The following chapter is based on regulatory aspects of food ingredients in the United States with the focus on the safety of enzyme preparations used in food. The authors explain the various aspects such as regulatory history of food ingredients, scientific advancement as part of the regulatory history of enzyme preparations, safety evaluation of enzyme preparations, identity of the enzyme and manufacturing process and composition.

In the chapter on trace element speciation in food, the authors discuss the implications of toxic elements such as arsenic, mercury, tin, chromium, cadmium on speciation for food safety. Elements such as selenium iron, cobalt, zinc, impact on the nutritional value of food are also discussed. Moreover, the authors examine the analytical methods for food elemental speciation analysis, species separation and species detection.

The book concludes with a chapter on bionanocomposites for natural food packing which discusses the natural biopolymer-based films such as polysaccharide films and protein films. Sections are given over to the modification of film properties such as natural nanoreinforcements, cellulose-based nanoreinforcements, starch nanocrystals/starch nanoparticles, chitin/chitosan nanoparticles, plant-protein nanoparticle, plasticizers, clays and active agents. The chapter concludes with a section on the environmental impact of bionanocomposites materials, their safety and toxicology, biodegradability and compostability.

The editors of this unique volume would like to express their sincere gratitude to all the contributors of this book, who made excellent support to the successful completion of this venture. We are grateful to them for the commitment and the sincerity they have shown towards their contributions in the book. Without their enthusiasm and support, the compilation of this book could not have been realized. We would like to thank all the reviewers who have taken their valuable time to make critical comments on each chapter. We also thank the publisher Scrivener-Wiley for recognizing the demand for such a book, and for realizing the increasing importance of the area of food science and technology.

Visakh. P. M
Sabu Thomas
Laura B.Iturriaga
Pablo Daniel Ribotta
January 1, 2013

List of Contributors

Elisabete Alexandre obtained her PhD in food science and technology from the College of Biotechnology, Portuguese Catholic University, Porto, Portugal, in 2011. She is currently working on chemical and physical phenomena in foods during processing. She has authored 2 book chapters, published 6 articles in referred international journals and co-authored 17 communications in scientific meetings.

Paula Berton is a PhD student in analytical chemistry, and is Laboratory Instructor at the National University of Cuyo, Mendoza, Argentina. She has co-authored 13 papers and 2 book chapters. Her research is focused on the use of ionic liquids for microextraction-based analytical methodologies for elemental speciation analysis.

Teresa R.S. Brandão is a chemical engineer with a PhD in biotechnology from the College of Biotechnology, Portuguese Catholic University. She is a researcher at the Centre for Biotechnology and Fine Chemistry of the Portuguese Catholic University. Her research interests have been focused on food processing, modeling quality and safety attributes of food products with emphasis in statistical experimental design procedures. She authored 8 book chapters, published 45 articles in referred international journals and co-authored more than 80 communications in scientific meetings.

Bibin Mathew Cherian is a scientist in the Department of Natural Resources at São Paulo State University. He has a PhD in chemistry, MSc in analytical chemistry and BSc in industrial chemistry, chemistry and mathematics. He is active in the field of biobased nanoreinforcements, nanocomposites, nanomedicine, membranes and medical implants.

Ligia Maria Manzine Costa is a PhD scholar at the Federal University of ABC. She has an MSc in materials engineering and a BSc in chemistry. Her research interests include electrospinning, polymeric nanofibers, resorbable polymers, bacterial cellulose, natural rubber latex.

Marcia Rodrigues de Moraes Chaves is a faculty member at the University of Sagrado Coração. She has a PhD in chemical engineering, MSc in materials engineering and a BSc in chemistry. Her research interests are in cellulose separation from different vegetable fiber sources and agro-industrial waste, as well on fiber-composite polymers and environmental aspects of these materials.

Giuseppe Cirillo received his PhD in 2008 from the University of Calabria, Italy. He is currently in a post-doctoral position at the same university and a visiting researcher at IFW Dresden, Germany, working on polymeric nanotechnologies and biomaterials. He is the author and co-author of more than 60 publications and the co-editor of the book *Antioxidant Polymers*.

Rui M.S. Cruz holds a PhD in biotechnology-food science and engineering. He works in the area of food preservation, particularly in active packaging to improve food products quality and extend shelf-life. He has published 12 peer-reviewed papers, 6 book chapters and 1 book edition, and he is also a reviewer for several scientific journals in the area of food science and technology.

Gabriel Molina de Olyveira is a PhD scholar at the Federal University of ABC. He has an MSc and BSc in materials engineering. He has experience in the rubber industry and manufacturing plastic packaging. His research interests include bioelectrochemistry, bionanotechnology, bionanocomposite and bionanomedicine.

Sivoney Ferreira de Souza is a PhD scholar at the Federal University of ABC. She has an MSc in energy in agriculture and BSc in chemical engineering. Her research interests include nanostructured materials especially cellulose nanofibers in biomedical application.

Ana Cristina Figueira is a coordinating professor of chemistry at the University of the Algarve, Portugal. Her scientific interests are

in food chemistry with a focus on food authenticity and the study of bioactive components of food and food by-products. She has co-authored 1 book, 7 book chapters and 11 scientific papers.

Igor Khmelinskii holds a PhD and Habilitation in chemistry. He has authored more than 150 peer-reviewed papers and 5 book chapters. His research interests include food analysis, photophysics, photochemistry, magnetic field effects, and climate change.

Tatik Khusniati is a senior food microbial biochemist, awarded as PhD from Hokkaido University, Japan in 2008. For the past 18 years she has been developing more intensive dairy food-microbial biochemistry research. She has a number of publications both in national and international journals in relation to dairy microbiology.

Alcides Lopes Leão is a Professor of College of the Agricultural Sciences at São Paulo State University. He has PhD in forestry, MSc in energy in agriculture and a BSc in agricultural engineering. He is the co-founder of ONG INFO, and International Natural Fibers Organization, based in Amsterdam, the Netherlands. He is active in the field of composites, natural fibers, recycling, biomass energy and agricultural and municipal garbage.

Estefanía Martinis holds a post-doc position at the National University of Cuyo, Argentina. She is the co-author of 14 publications and 1 book chapter. She works in the field of development of analytical methods for toxic elements determination at trace levels using functionalized nanomaterials and ionic liquids.

Rafael Germán Campos Montiel is a researcher at the Autonomous University of Hidalgo State, Argentina and has experience in extraction of bioactive compounds from microorganisms and plants used as additives in foods. He has published 3 books, 8 chapters and 11 scientific papers in several journals. He has also worked in the Hidalgo state government solving food industries problems.

Suresh Narine is the Ontario Research Chair in Green Chemistry and Engineering and NSERC/GFO/ERS Industrial Research Chair in Lipid Derived Biomaterials, is a professor of physics and astronomy and chemistry at Trent University and Director of the Trent

Centre for Biomaterials Research in Canada. He has a PhD in food science, a MSc in condensed matter physics and a BSc in chemical physics.

Ortensia Ilaria Parisi obtained her PhD in environment, health and eco-friendly processes with a thesis on "Polymeric Materials for Biomedical Applications: Synthesis and Characterisation". Her research interests are in the areas of biomaterials, molecularly imprinted polymers, graft polymers, functional polymers, stimuli responsive hydrogels as well as functional foods and nutraceuticals. She is author of more than 40 publications regarding the above-mentioned topics.

Nevio Picci received his degree in chemistry in 1975 from the University of Pisa and he is currently full professor in pharmaceutical technology at the University of Calabria, Italy. His research interest involves the application of functional polymers, biomaterials and nanotechnologies in biomedical, pharmaceutical and food sciences. He is the author and co-author of more than 150 publications.

Diana Pimentel is a researcher at the Autonomous University of Hidalgo State, Argentina and has experience in food technology with specific expertise encapsulating bioactive compounds and probiotics. She has published 16 scientific papers in several journals. She has received Pan-American and Latin-American awards for her pioneering contributions recognized by international companies like Bimbo and Kellogs.

Francesco Puoci earned his BS in chemistry from the University of Calabria in 1999 and his PhD in 2002. His research activities focus on the synthesis of polymeric functional materials for pharmaceutical and technological applications as well as functional foods and nutraceuticals.

Endang Sutriswati Rahayu is a senior lecturer at the Faculty of Agricultural Technology, Gadjah Mada University, Yogyakarta, Indonesia. She received her PhD in agricultural chemistry from the University of Tokyo, Japan in 1991. Her research and publications are mainly related to lactic acid bacteria (fermented foods and probiotics) and food safety (foodborne fungi and mycotoxin). She belongs to several professional associations such as the Asian Federation

Society for Lactic Acid Bacteria and the Indonesian Society for Lactic Acid Bacteria, Microbiologist, and Food Technologist.

Javiera F. Rubilar is a researcher at the Department of Chemical Engineering and Bioprocesses of the Pontificia Universidad Católica de Chile. She holds a PhD in chemistry and has published 3 peer-reviewed papers. In 2011 she won third place in the best research presentation award at the ISEKI Food conference.

Donatella Restuccia is an assistant professor of commodity sciences at the Department of Pharmacy and Health and Nutrition Sciences of the University of Calabria. Research activity is principally focused on food quality and safety evaluation and in particular on the determination of natural contaminants and bioactive compounds in foods. She is the author or co-author of about 60 publications.

Cristina L.M. Silva is a chemical engineer with PhD in Biotechnology from the College of Biotechnology, Portuguese Catholic University. She is an associate professor at the College of Biotechnology and a senior researcher at the Centre for Biotechnology and Fine Chemistry of the Portuguese Catholic University. She is the leader of a research team involved in thermal and non-thermal food processing, focusing on process optimisation and development of strategies for food quality and safety. She has authored 11 book chapters, published 80 articles in referred international journals and co-authored more than 150 communications in scientific meetings.

U. Gianfranco Spizzirri received his PhD from the University of Calabria in 2005. His research is focussed on the synthesis of polymeric functional materials for technological applications. Particular interest is devoted to development of specific experimental protocols in the evaluation of active components in nutraceutical supplements and food matrices. He is the author and co-author of more than 50 publications.

Jannavi Srinivasan is a review chemist in the FDA's Office of Food Additive Safety. Her expertise includes bioengineered crops and enzymes added to food. She has a PhD from Wayne State University Detroit. She was a postdoctoral fellow at University of Michigan and has worked for ten years in the industry.

Margarida C. Vieira is a Professor Coordinator (PhD) and Head of the Department of Food Engineering (ISE-UAlg) since 2009. Her main research area is innovative technologies for food preservation. She has published 16 peer-reviewed papers, 10 book chapters and edition of 2 books. In 1999 she won the first place in the Product Development Division's Poster Competition at the IFT Annual Meeting.

Giuliana Vinci is an associate professor of commodity science at the Department of Management of Sapienza University of Rome. The author of several publications (150) in national and international journals relating food quality, food security and sustainable development.

Shayla West-Barnette is a consumer safety officer in FDA's Office of Food Additive Safety where she serves on the Enzyme Review Team as well as a microbiology reviewer. She holds a bachelor's degree in biology from Bennett College and a PhD in microbiology and immunology from Wake Forest University.

Yantyati Widyastuti is a highly distinguished animal nutritionist. She obtained her PhD from Tokyo University of Agriculture, Japan in 1989. She is a leader of animal nutrition research group and head of Applied Microbiology laboratory in the Research Center for Biotechnology, Indonesian Institute of Sciences. She has published a number of papers in several international journals.

Rodolfo Wuilloud is a Professor at the National University of Cuyo and Researcher at the National Council for Scientific and Technical Research (CONICET) of Argentina. He is the author of 79 papers and 3 book chapters. His research focuses on development of analytical methods for elemental speciation based on microextraction techniques using ionic liquids and solid-phase preconcentration.

Contents

Preface	xi
List of Contributors	xv
1 Food Chemistry and Technology	1
<i>Visakh P. M., Sabu Thomas, Laura B. Iturriaga and Pablo Daniel Ribotta</i>	
1.1 Food Security	1
1.2 Nanotechnology in Food Applications	4
1.3 Frozen Food and Technology	5
1.4 Chemical and Functional Properties of Food Components	7
1.5 Food: Production, Properties and Quality	8
1.6 Safety of Enzyme Preparations Used in Food	10
1.7 Trace Element Speciation in Food	11
1.8 Bio-nanocomposites for Natural Food Packaging	13
References	14
2 Food Security: A Global Problem	19
<i>Donatella Restuccia, Umile Gianfranco Spizzirri, Francesco Puoci, Giuseppe Cirillo, Ortensia Ilaria Parisi, Giuliana Vinci and Nevio Picci</i>	
2.1 Food Security: Definitions and Basic Concepts	20
2.2 Main Causes of Food Insecurity	27
2.2.1 Social Issues	28
2.2.2 Economic Issues	36
2.2.3 Environmental Issues	41
2.3 The Food Insecurity Dimension	50
2.3.1 Current Situation at Global Level	50
2.3.2 The Food, Financial and Economic Crisis and Their Implications on Food Security	55

2.3.3	The Last Concern: Food Prices Volatility	65
2.3.4	The Food Sector Numbers: Trends in Global Food Production and Trade	72
2.4	Conclusions	93
	References	95
3	Nanotechnology in Food Applications	103
	<i>Rui M. S. Cruz, Javiera F. Rubilar, Igor Khmelinskii and Margarida C. Vieira</i>	
3.1	What is Nanotechnology?	103
3.2	Food Formulations	105
3.3	Food Packaging	107
3.3.1	Enhanced Barrier Properties	107
3.3.2	Active Packaging	112
3.3.3	Intelligent Packaging	114
3.4	Regulation Issues and Consumer Perception	115
	Acknowledgements	116
	References	116
4	Frozen Food and Technology	123
	<i>Elisabete M.C. Alexandre, Teresa R.S. Brandão and Cristina L.M. Silva</i>	
4.1	Introduction	124
4.2	Treatments: Pre-freezing	125
4.2.1	Fruits and Vegetables	125
4.2.2	Fish Products	127
4.2.3	Meat Products	128
4.3	Freezing Process	129
4.4	Freezing Methods and Equipment	131
4.4.1	Freezing by Contact with Cold Air	131
4.4.2	Freezing by Contact with Cold Liquid	135
4.4.3	Freezing by Contact with Cold Surfaces	135
4.4.4	Cryogenic Freezing	136
4.4.5	Combination of Freezing Methods	137
4.4.6	Innovations in Freezing Processes	137
4.4.7	Food Products and Freezing Methods	139
4.5	Effect of Freezing and Frozen Storage on Food Properties	142
4.5.1	Physical Changes	142
4.5.2	Chemical Changes	143
4.5.3	Microbiological Aspects	145

4.6	Final Remarks	146
	References	147
5	Chemical and Functional Properties of Food Components	151
	<i>Campos-Montiel R.G. , Pimentel-González D.J. and Figueira A.C.</i>	
5.1	Introduction	151
5.2	Functional and Chemical Properties of Food Components	152
5.2.1	Functional Foods: Historical Perspective and Definitions	152
5.2.2	Legislation on Functional Food Claims	153
5.2.3	Classification of Functional Foods	161
5.2.4	Functional Properties of Food Components	162
5.3	Nutritional Value and Sensory Properties of Food	168
5.3.1	Nutritional Value of Food	169
5.3.2	Sensory Properties of Food	172
5.4	Postharvest Storage and Processing	174
5.4.1	Bioactive Compounds Postharvest	174
5.5	Conclusion	177
	Acknowledgements	178
	References	178
6	Food: Production, Properties and Quality	185
	<i>Yantyati Widyastuti, Tatik Khusniati and Endang Sutriswati Rahayu</i>	
6.1	Introduction	185
6.2	Food Production	186
6.3	Factors Affecting Production and Improvement of Food	187
6.3.1	Soil and Climate	187
6.3.2	Population and Income Per Capita	188
6.3.3	Technology	188
6.3.4	Plant Source Foods	191
6.3.5	Animal Source Foods	193
6.4	Food Properties	196
6.5	Food Quality	197
	References	199